HIGHWAY RESEARCH REPORT

SELECTION OF OPTIMUM BINDER CONTENT FOR BITUMINOUS TREATED BASES

FINAL REPORT

STATE OF CALIFORNIA

BUSINESS AND TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

MATERIALS AND RESEARCH DEPARTMENT

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16. ABSTRACT

This report discusses a test method for selecting the optimum asphaltic binder content necessary to treat an in-place material in order to make it suitable for use as a bituminous treated base. This method was developed considering cohesion (tensile strength) as determined by the California Cohesiometer and the reduction in permeability and capillary action of the bituminous treated materials as measured by a 5-day moisture absorption of the mixture. Also discussed are the suitability of material for treatment and the use of liquid asphalts and emulsions used for treatment. The report recommends additional study to determine structural thickness design requirements.

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DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
MATERIALS AND RESEARCH DEPARTMENT
5900 FOLSOM BLVD., SACRAMENTO 95819

January 1973

Final Report
M&R No. 633378
FHWA No. D-2-15

Mr. Robert J. Datel
State Highway Engineer

Dear Sir:

Submitted herewith is a research report titled:

SELECTION OF OPTIMUM BINDER CONTENT

FOR BITUMINOUS TREATED BASES

George B. Sherman
Principal Investigator

Melvin H. Johnson
Co-Investigator

Thomas Scrimsher & Gary W. Mann
Analysis & Report

Very truly yours,

JOHN L. BEATON
Materials and Research Engineer

ACKNOWLEDGMENT

This work was performed in cooperation with the U. S. Department of Transportation, Federal Highway Administration, under agreement No. D-2-15. The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

A special note of appreciation goes to S. M. Shadle and R. E. Morrison of the Materials and Research Department of the California Division of Highways for their laboratory work and assistance with data analysis.

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INTRODUCTION

The possibility of upgrading local and in-place materials with a bituminous treatment has been a topic for serious consideration over the years. A depletion of high quality aggregates and increasing local restrictions on the development of new aggregate sources has resulted in increased interest in the use of treated in-place or borrow type materials as bases.

Many unprocessed materials in California can benefit by bituminous treatment, some more so than others, because of their grading or physical makeup. The primary benefits to be realized from bituminous treatment are increased tensile strength (cohesion) and/or resistance to water action. The extent and type of benefit derived will be influenced by the physical characteristics and gradation of the material being treated. Sands will improve mostly by increased tensile strength and silty type materials by waterproofing of the fines (1).

A literature search revealed that various laboratory methods have been developed to determine if a material was suitable for treatment and to evaluate the effect of the treatment (1,2,3). Researchers have established suitability requirements on the untreated material such as minimum sand equivalent, maximum percent passing the No. 200 sieve and maximum plasticity index. However, it was felt that a satisfactory method of determining the amount of bituminous binder necessary to achieve adequate tensile strength and waterproofing action was not available. This included the need of determining a suitable laboratory method of subjecting test specimens to water action which would be representative of the type of action that base type materials would be subjected to in the field.

This report discusses the work done on the determination of binder content and laboratory methods of subjecting test specimens to water action. A third area in need of investigation is a design method to determine structural thickness requirements after bituminous treatment. However, this will have to be investigated in conjunction with field application.

It was found through the literature search that there is a general lack of universal definition regarding the use of asphalt treated bases. The term used in this study, "bituminous treated bases", by our definition will be any material designated as base material that is treated either by road-mixing or plant-mixing methods with an emulsion or liquid asphalt.

CONCLUSIONS

1. A method for determining the optimum binder content for bituminous treated bases was developed (see Appendix).

2. A method was developed (Capillary Absorption Test) that subjects the specimen to severe moisture conditions by capillary action while leaving it confined in its fabricating mold. This method allows the specimen to be measured for swell as well as water resistant qualities in the same apparatus.

3. Materials used in this experiment with sand equivalent values less than 30 and having more than 30 percent passing the No. 200 sieve may not be satisfactory for bituminous treatment. These materials were extremely difficult to mix in the laboratory and should be field tried before full scale project use.

4. In this study, medium curing grade liquid asphalts did not properly cure under laboratory conditions. Generally, rapid curing products gave better laboratory tests results. However, it is felt, the selection of the proper product for field use will depend upon gradation, field drying conditions, etc. that influences the rate of cure.

RECOMMENDATION

Additional work should be done to investigate the structural thickness requirements of bituminous treated bases. Until this can be done a gravel equivalent of 1.2 should be used for bituminous treated bases in the California flexible pavement design method.

IMPLEMENTATION

The design method can be implemented on one or more field projects.

DISCUSSION

Material Selection

Material sources to be used for bituminous treatment will vary considerably with location throughout the State. For purposes of this study samples were taken at four locations, and are considered to cover a wide spectrum of materials that could be considered for bituminous treatment in California. The materials were identified as:

Test No. 69-2629 (Silty Sand from Kings County near Fresno)
Test No. 69-2599 (Sandy Silt from San Joaquin County near Stockton)
Test No. 68-2428 (River Sand from Yolo County near Sacramento)
Test No. 69-2603 (Decomposed Granite from El Dorado Co. near Lake Tahoe)

For the physical properties of these materials see Table 1.

The Chevron Asphalt Company (1) has recommended that a material have a minimum 30 sand equivalent to be considered for bituminous treatment. Douglas Oil Company (3) states that for good success tuminous treatment a material should have a minimum 25 ...ivalent, a maximum plasticity index of 5 and no more than ...ent of the material passing the No. 200 sieve. It can be ...hat the San Joaquin County material does not meet the ... minimum sand equivalent requirement but does meet Douglas's. ...r, it does not meet Douglas's requirements for plasticity ...and percent passing the No. 200 sieve. The Kings County ...ial has more material passing the No. 200 sieve than Douglas ...ends for good success; however, it meets all of the other ...-mentioned criteria. The materials from Yolo and El Dorado ...ies are well within the established criteria for successful ...inous treatment.

...though there was some question as to the suitability of the ...rials from San Joaquin and Kings Counties for bituminous treat... they were included in the study to further verify suitability ...irements. Their laboratory performance will be discussed later this report.

...lection of Asphaltic Binder

... grading of aggregates will influence asphaltic binder selection. ...iner materials may resist mixing with liquid asphalts and yet be ...itable for use with emulsions. The most commonly used bituminous ...tabilizers in California are rapid and medium curing liquid asphalts ...and emulsions, therefore these materials were used in this study. The 250 grade liquid asphalts were selected for this study because it was felt they would provide sufficient viscosity to promote good workability yet would not require an excessive amount of time to cure. There are many types of medium and slow setting emulsions that perhaps could be used for bituminous treatment; however, the SS-1 grade was selected for this study. A cationic emulsion will generally be used with silica type aggregates and an anionic with other types.

Compaction Procedure

In the testing program of bituminous treated bases consideration was given to the compaction procedures used to fabricate test specimens. The data supplied from a report prepared by the Asphalt Institute in July 1957 on the Bear Mountain project (4) near Los Angeles, indicated that cores taken after construction were comparable with densities of laboratory compacted mixtures using the California kneading compactor at 500 psi pressure and 150 tamping blows. Most materials selected for this current study contained a large percentage of sand and would not consolidate under the foot of the kneading compactor. Previous experience in California indicates that with such sandy materials a 40,000 pound static load applied with a double plunger would very closely simulate the densities obtained for the above condition with the kneading compactor. Therefore this compaction method was selected for this study.

Moisture Absorption

As mentioned in the introduction, there was a need for a tes which will subject a compacted specimen to similar condition moisture that will exist in the field. The initial tests eva were the Moisture Vapor Susceptibility Test (Test Method No. 307), the Swell Test (Test Method No. Calif. 305), and the S- Bath Test (see Figure 3).

The Moisture Vapor Susceptibility Test is a standard routine t in California used to evaluate the effect of moisture vapor on asphalt concrete surfacing. The test consists of compacting a specimen in the routine manner with the kneading compactor, placing an aluminum disc on top of the specimen and sealing around the edges with an air blown asphalt mixture. A felt wic is placed on the bottom of the specimen and allowed to drop into a pan of water. The entire unit is then placed into a 140°F ove for 72 hours, removed and tested for stability, cohesion, and moisture content.

The original purpose for the development of the M.V.S. Test was t measure the effect of moisture vapor on bituminous mixes containi an optimum asphalt content, by noting variations in the stabili-ometer value. However, this test method was used in this study to measure only the moisture uptake with time. After 5 days very little moisture was noted in the test specimens (see Figures 4-7). It was felt this test method would not be severe enough to duplica the moisture anticipated in base materials.

The next method tried was the Swell Test. The normal Swell Test d not result in a specimen taking up an appreciable amount of moistur and was modified to allow for complete immersion of a test specimen for periods of 24 hours, 48 hours, and 5 days. After 5 days this modified test resulted in a specimen absorbing more moisture than all the other methods (see Figures 4-7); however, it was felt that flooding and soaking the specimen was, in reality, too severe, and only rarely would occur in the field.

The Sand Bath Test, used in 1957 to study the Bear Mountain project, was the next method considered. This method subjects a compacted mixture to moisture by surrounding the specimen with wet sand and allowing the specimen to absorb moisture slowly. In a five day test, a specimen absorbed considerably more moisture than the M.V.S. Test but less than the Swell Test (see Figures 4-7). This test method subjects the specimen to moisture in an unconfined manner and, as a result, the specimen expands and becomes unsuitable for additional testing (i.e., stability or cohesion). Therefore, it was decided to modify the Sand Bath Test in such a way that the specimen would be subjected to moisture in the same manner as the Sand Bath Test, yet still be usable for other testing after soaking.

As a result a test referred to as the "Capillary Absorption Test" was developed. This test, similar to the Sand Bath, subjects the specimen to the same moisture conditions, however, the specimen is kept confined by leaving it in its fabricating mold (see Figure 1).

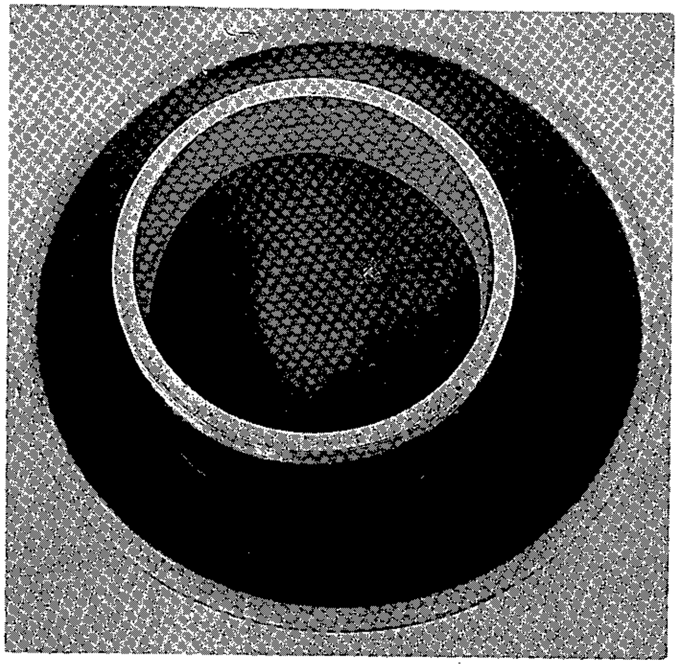

Figure 1

Capillary Absorption Test Equipment

Figure 2

Capillary Absorption Test Equipment - Assembly View

Early development of this test indicated that after the wetting period any movement of the specimen still resulted in damage as the wetter lower half would fall from the mold when lifted. To eliminate this problem a rigid filter paper (1/8" thick) was glued to the bottom of the mold after the specimen was fabricated and before subjecting it to moisture. This approach was good with materials that had little expansion. However, with expansive materials, as the soil took on water, the expansion caused the filter paper to accept a convex shape away from the mold as much as 1/4 inch. In some cases the expansion literally ripped the filter from the bottom. To eliminate this problem, it was decided to thread the outside of the fabricating mold and screw on a brass perforated cap (see Figure 2). With this approach the moisture uptake paralleled the Sand Bath Test (see Figures 4-7) and the specimen could be removed later for other testing. This method also allowed the rate of moisture uptake to be determined by simply weighing the entire assembly periodically. The amount of swell or expansion may also be determined with this system. It was noted using this system that most aggregates will reach their ultimate moisture content after a 10 day period, and that about 70 percent of the moisture was absorbed by the fifth day (see Figures 8-11). Therefore to shorten the test as much as possible it was decided to limit the test to five days and evaluate the results at this point.

With the test method for moisture uptake determined, it became necessary to establish limits that could be expected to be compatible with good field performance. The maximum allowable moisture absorption was set at five percent to represent moisture content in the soil during midsummer. This figure, of course, will vary throughout the State and with various soils, but it was felt five percent would be conservative for the majority of cases. If future field studies indicate otherwise, adjustments can be made in this phase of the design method.

Physical Property Considerations

The next consideration was the determination of adequate improvement in cohesion (tensile strength). It was felt that a minimum design cohesion value must be selected that would provide sufficient strength immediately after construction to provide a stable working table. This cohesion is considered early cohesion and as the mixture cures, an increase in cohesion will occur, resulting in increased strength. It was difficult to establish a minimum value due to a lack of data and experience with the mixtures under consideration. Samples taken immediately after final laydown on the Bear Mountain job (5) had cohesions ranging from 67 to 210 at room temperature. It was felt that since the laboratory specimens are aged at 140°F prior to testing, they should have at least a 100 cohesion value at room temperature after being subjected to the absorption test; therefore this minimum cohesion value was selected for the design method developed in this study. (This value may also be altered if future field studies so dictate.)

The question of a gravel equivalency factor for asphalt treated materials has been a source of study for an experimental base project near San Diego. The project consisted of 35 different test sections representing asphalt treated and untreated base materials surfaced with 0.25' asphalt concrete. Performance criteria was collected annually including deflection measurements and the present analysis is based on 5 years of study. Unpublished analysis of the data by both The Asphalt Institute and the California Division of Highways has indicated a wide range of equivalency values (6,7). Data collected to date indicates that gravel equivalencies for treated bases can range in value from 1.2 to 1.6. Therefore, until further evaluation can be performed it would seem that the gravel equivalency value for sand asphalt bases should be limited to 1.2. It does not appear feasible at present to adjust this value for changes in Traffic Indices since additional performance criteria is needed.

Laboratory Analysis of the Selected Materials

The four materials selected from throughout the State were evaluated on the basis of the previously discussed criteria. That is, the water absorption of the treated material must be less than 5 percent after testing by the Capillary Absorption Method and the cohesion value must be greater than 100 after this 5 day soaking period (see Appendix for testing procedure). The results of this analysis are presented in Table 2 and illustrated graphically in Figures 12-15.

It can be seen that the San Joaquin County sandy silt has high cohesion values regardless of the binder content. This is to be expected bacause, as prevsiouly mentioned, the greatest improvement to be expected by treating a silty material would be in waterproofing of the fines. It took quite a bit of RC-250 (10%) and SS-1 (13%) to meet the maximum 5% water absorption criteria. Therefore, economics alone would tend to disqualify this material from consideration for bituminous treatment. Also, in the laboratory this material was extremely hard to mix and handle which may also be the case in the field. This material would be considered unsuitable for treatment by the criteria established by other researchers (1 and 3), and the above findings also indicate it may be unsuitable for bituminous treatment by our laboratory testing.

It is interesting to note that this is the only material in this study which meets the minimum 100 cohesion criteria when treated with MC-250. This is probably due to the fact that the large amount of fines in this material contributed to the cohesion and very little improvement is required from the asphalt binder, which is not the case with the other three materials.

The Kings County silty sand was able to meet part of the design criteria when treated with 8% of either RC-250 or SS-1. The material could not meet the cohesion criteria when treated with MC-250, regardless of the amount of binder added. This is probably due to the fact that the MC product did not cure properly. This is the case even though the test specimens were oven cured. This does not rule out MC-250 from consideration as a treatment product for all base materials and one could argue that better curing will be experienced in the field; however, the fact remains that careful thought should be given to the use of an MC product to insure that sufficient curing will occur.

The Kings County material had more material passing the No. 200 sieve (30 percent) than previously mentioned criteria (3) recommends and there was also some difficulty with mixing and some balling of asphalt. However, if other considerations warrant treatment, these difficulties should not classify it as unsuitable for treatment. Here again, when there is a significant amount of fines, the bituminous treatment generally appears to contribute more to the waterproofing of the material than to the cohesion improvement.

The Yolo County sand was the most suitable material for bituminous treatment. It required only 3 percent SS-1 or 4 percent RC-250 for the material to meet the design criteria. Again the addition of MC-250 did not raise the cohesion to an acceptable level and the previous remarks concerning curing would also be pertinent in this case. As would be expected with a sand having 0 percent passing the No. 200 sieve, the greatest effect of the bituminous binder was to improve the cohesion, and the binder content had very little effect on the waterproofing.

The El Dorado County decomposed granite required 5 percent RC-250 or 7 percent SS-1 to meet the established design criteria. Again treatment with the MC-250 liquid asphalt did not raise the cohesion to acceptable limits, and the curing comments are pertinent. In this case also, with a predominently sandy material, the addition of a bituminous binder had more of a pronounced effect on the water absorption than on the cohesion.

With the El Dorado County material, it can be seen that with the addition of RC-250 the cohesion increases to a maximum amount and then sharply decreases. This is also evident with the other materials. This phenomenon is probably due to the curing situation. With the increase in binder content and the corresponding increase in solvent, it is not possible for the material to cure properly. It is true that with time the binder will cure and perhaps have a very high cohesion; however, this indicates that if too much binder is added to a material it will not be possible to work on the material until later after sufficient curing occurs.

This study indicates that the best liquid asphalt to use for bituminous treatment may be the RC grade. Since the SS grade emulsion cured sufficiently it would seem logical that a medium setting emulsion would prove satisfactory as a binder from the curing aspect.

In actual practice where plant mixing may be employed, more viscous liquid asphalts could be used and in wome cases material that may not meet the design criteria with a 250 grade might be acceptable with the heavier grades. The method of mixing and/or the grade of binder proposed for use should be evaluated by the laboratory.

Generally, it is suggested that a minimum binder content of no less than three percent be used regardless of minimum amounts determined by the test method. This is the present opinion of the researchers with the limited amount of field experience to date. Mixing variance will probably be the limiting factor for the minimum allowable binder content. The maximum binder content may be a function of economics. Extremely high asphalt contents may stabilize even poor materials.

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TABLE 1

Physical Properties of Materials Sources Tested

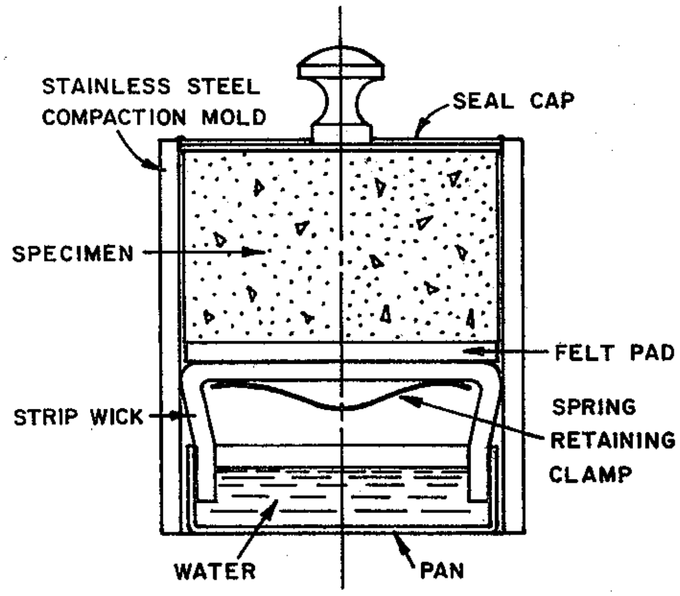
Source	Kings County	San Joaquin County	Yolo County	El Dorado County
	Silty Sand	Sandy Silt	River Sand	Decomposed Granite
Sieve	% Passing	% Passing	% Passing	% Passing
4				100
8	100	100		93
16	99	98	100	77
30	97	96	96	50
56	83	93	41	25
100	51	90	4	9
200	30	81	1	4
Specific Gravity	2.68	2.75	2.68	2.68
Plasticity Index	N.P.	7	N.P.	N.P.
Sand Equivalent	33	27	82	73
R-Value	69	31	71	80

TABLE 2

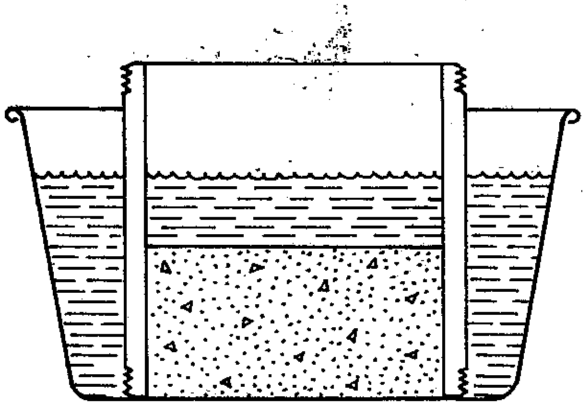
Binder Recommendations (% by Dry Weight of Aggregate)

Binder	Kings County Silty Sand	San Joaquin County Sandy Silt	Yolo County River Sand	El Dorado County Decomposed Granite
RC-250	8.0	10.0	4.0	5.0
MC-250	cannot use	7.0	cannot use	cannot use
SS1-Emuls.	8.0	13.0	3.0	7.0

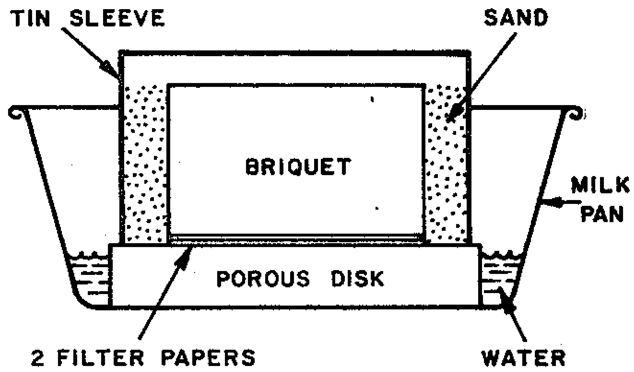
Figure 3.



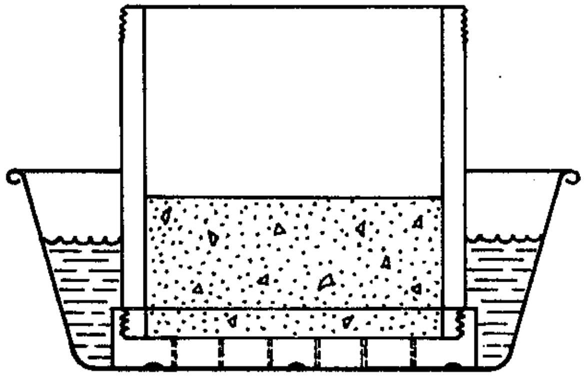
M.V.S. TEST



IMMERSED SWELL



SAND BATH ASSEMBLY



CAPILLARY ABSORPTION

Figure 4

KINGS COUNTY
SILTY SAND

MC-250 (5%)
MOISTURE ABSORBED FOR VARIOUS TEST METHODS

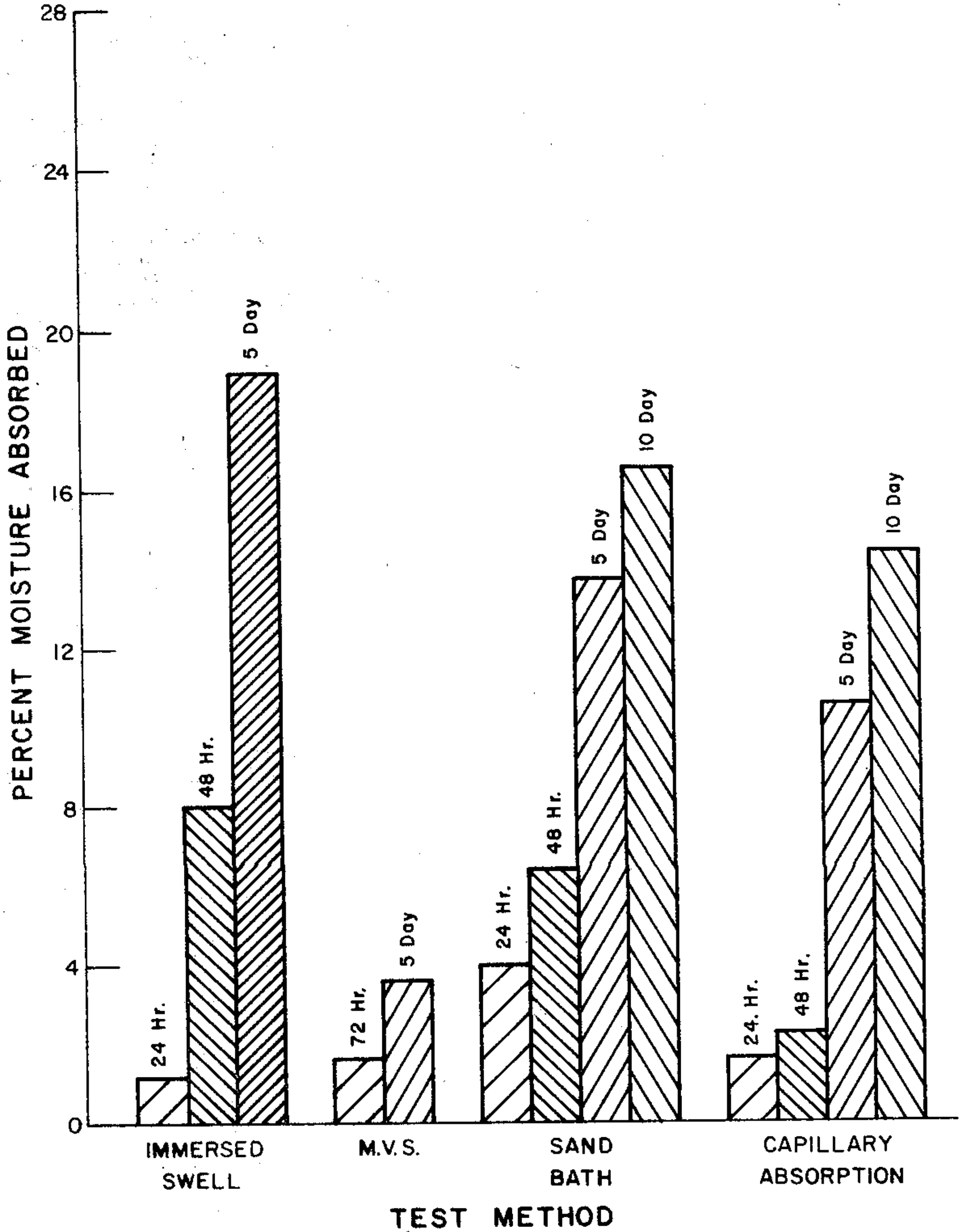


Figure 5

SAN JOAQUIN COUNTY
SANDY SILT

MC-250 (5%)

MOISTURE ABSORBED FOR VARIOUS TEST METHODS

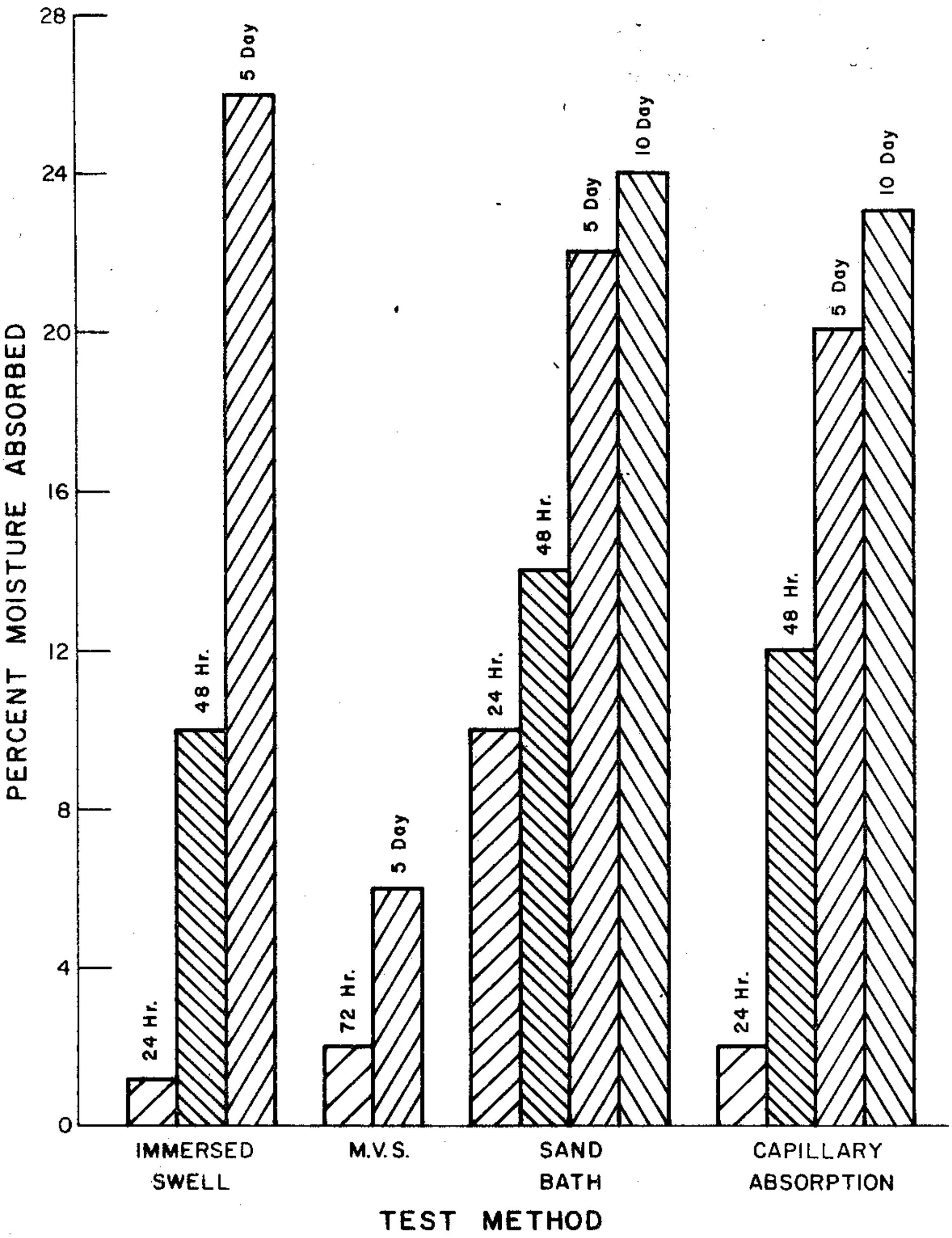


Figure 6

YOLO COUNTY
SAND
MC-250 (5%)
MOISTURE ABSORBED FOR VARIOUS TEST METHODS

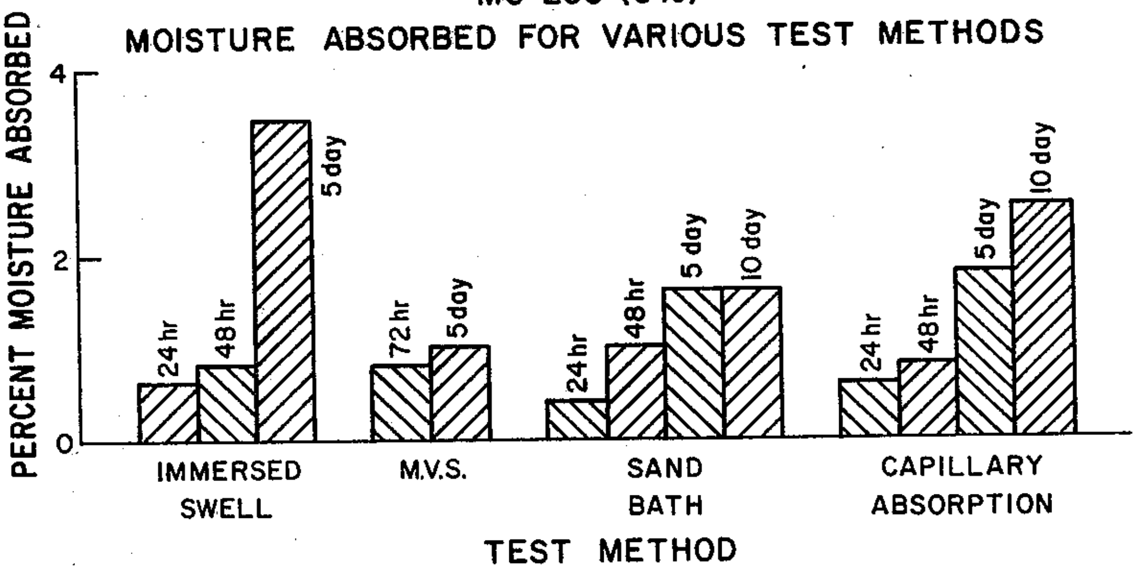


Figure 7

EL DORADO COUNTY
DECOMPOSED GRANITE
MC-250 (5%)
MOISTURE ABSORBED FOR VARIOUS TEST METHODS

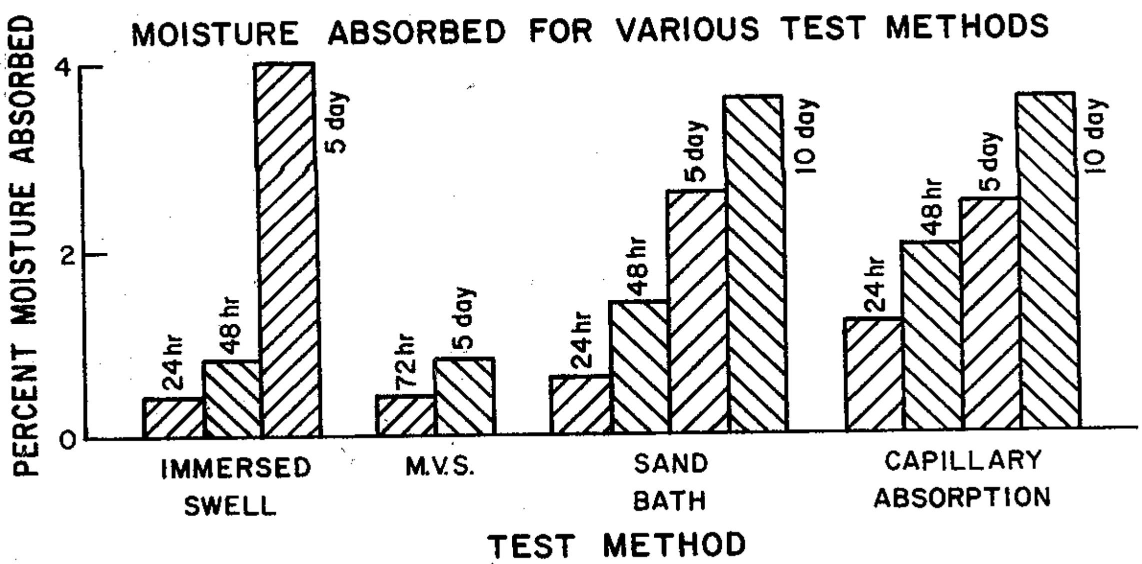
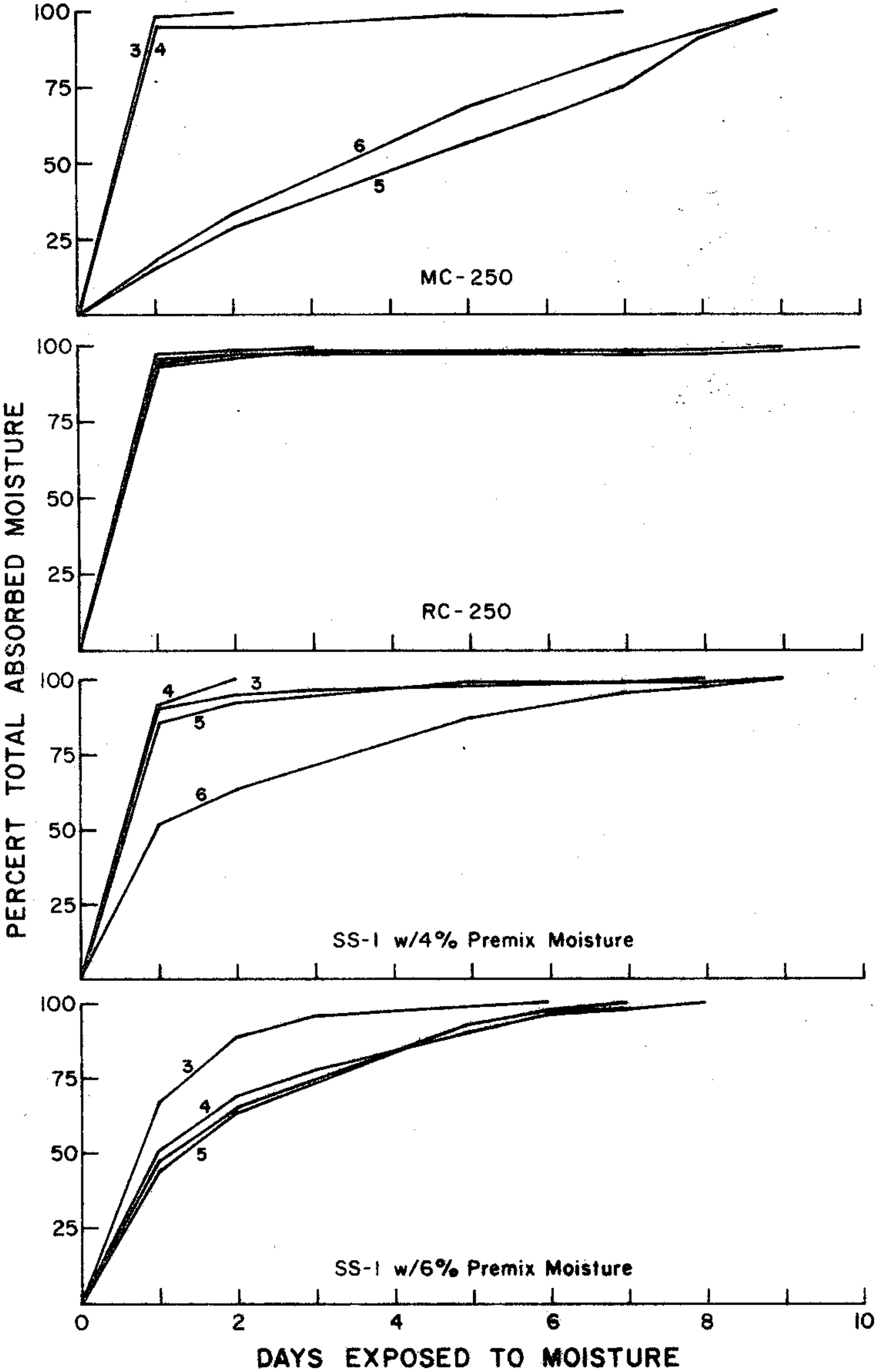


Figure 8

KINGS COUNTY SILTY SAND

TIME REQUIRED FOR CAPILLARY ABSORPTION TEST



MC-250

% Binder	Total Absorb. Moist.
3	19.6
4	18.7
5	13.3
6	8.8

RC-250

% Binder	Total Absorb. Moist.
3	17.6
4	17.2
5	16.3
6	14.9

SS-1 w/4% Premix Moisture

% Binder	Total Absorb. Moist.
3	9.2
4	7.8
5	7.5
6	5.4

SS-1 w/6% Premix Moisture

% Binder	Total Absorb. Moist.
3	5.0
4	4.5
5	5.9
6	5.7

Figure 9

SAN JOAQUIN COUNTY SANDY SILT

TIME REQUIRED FOR CAPILLARY ABSORPTION TEST

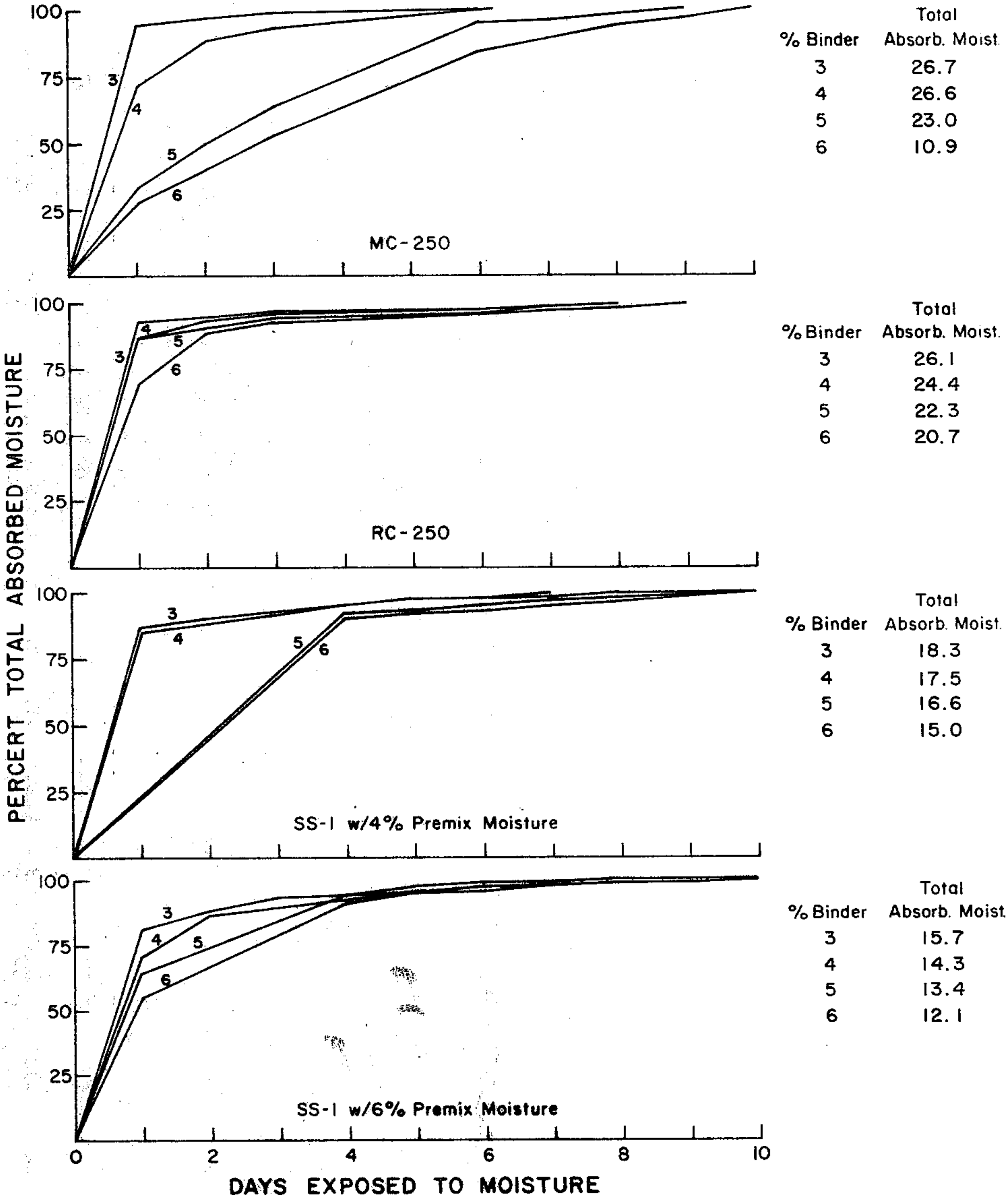
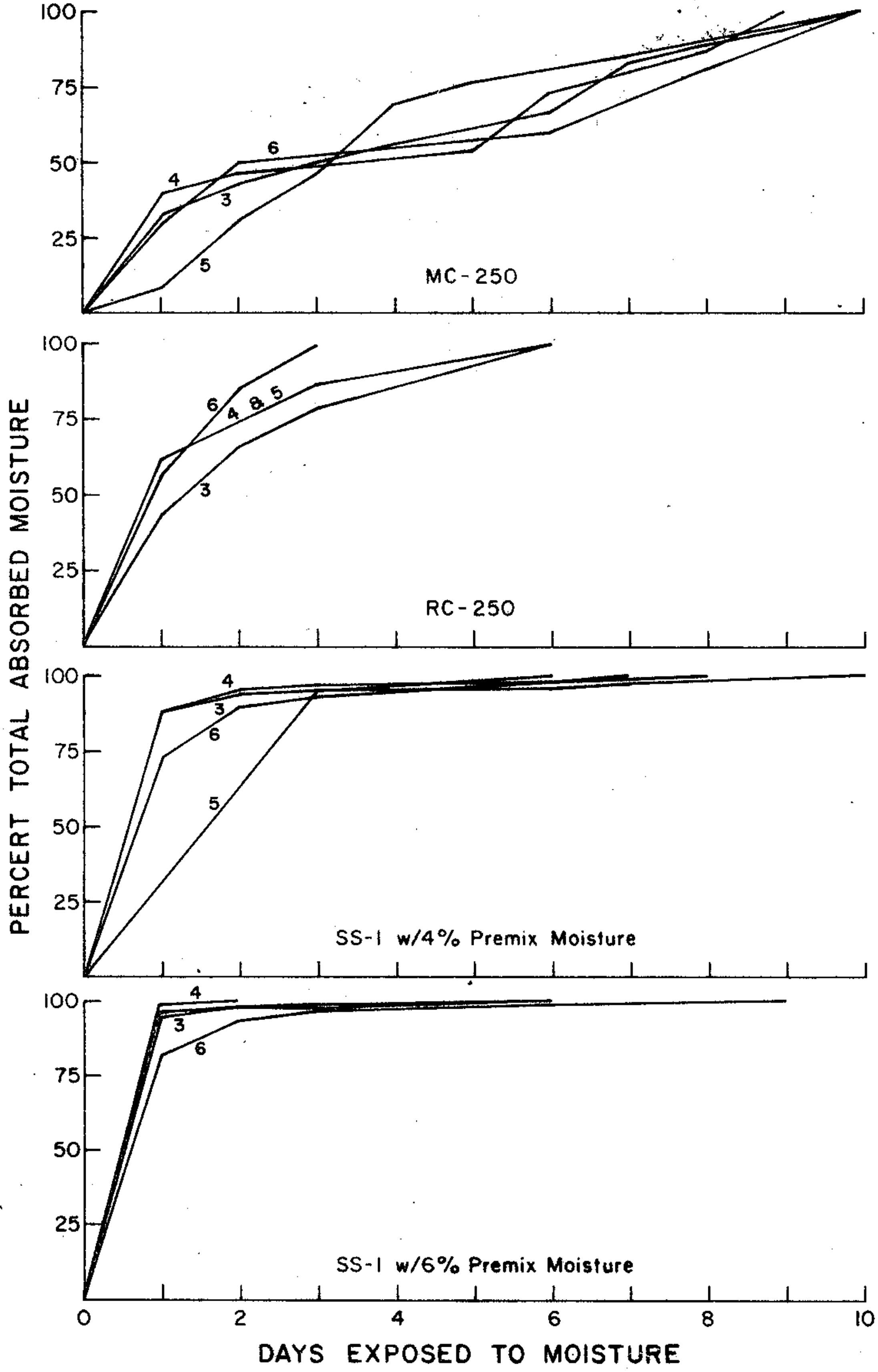


Figure 10

YOLO COUNTY SAND

TIME REQUIRED FOR CAPILLARY ABSORPTION TEST



MC-250

% Binder	Total Absorb. Moist.
3	1.8
4	1.5
5	1.3
6	1.0

RC-250

% Binder	Total Absorb. Moist.
3	0.9
4	0.8
5	0.8
6	0.7

SS-1 w/4% Premix Moisture

% Binder	Total Absorb. Moist.
3	12.9
4	11.8
5	10.9
6	8.9

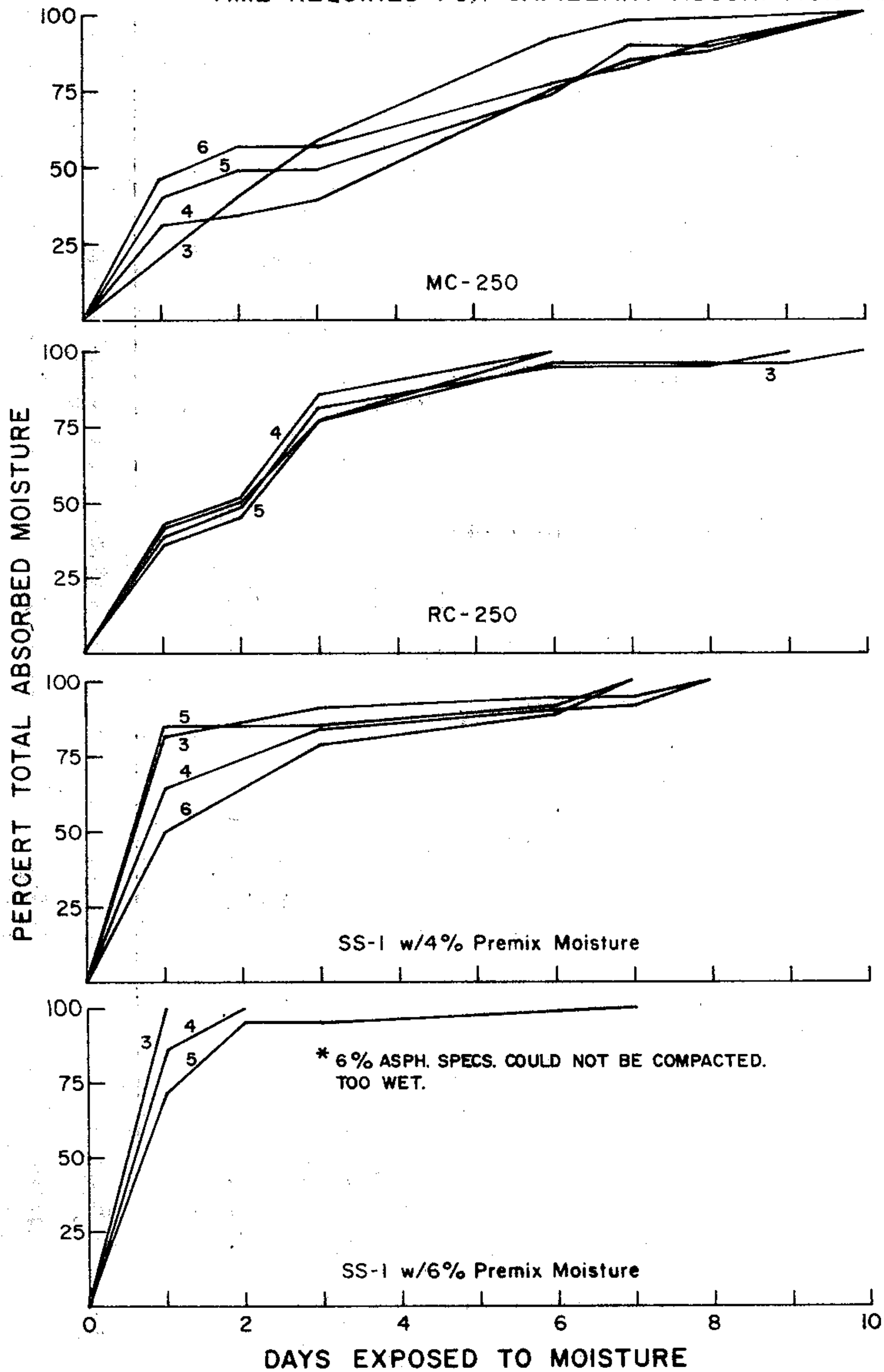
SS-1 w/6% Premix Moisture

% Binder	Total Absorb. Moist.
3	12.5
4	10.5
5	8.4
6	7.2

Figure 11

EL DORADO COUNTY DECOMPOSED GRANITE

TIME REQUIRED FOR CAPILLARY ABSORPTION TEST



MC-250

% Binder	Total Absorb. Moist
3	12.4
4	5.1
5	3.5
6	3.0

RC-250

% Binder	Total Absorb. Moist.
3	2.6
4	2.1
5	2.2
6	2.1

SS-1 w/4% Premix Moisture

% Binder	Total Absorb. Moist.
3	9.1
4	6.7
5	5.5
6	5.2

SS-1 w/6% Premix Moisture

% Binder	Total Absorb. Moist.
3	7.1
4	5.1
5	4.3
6	*

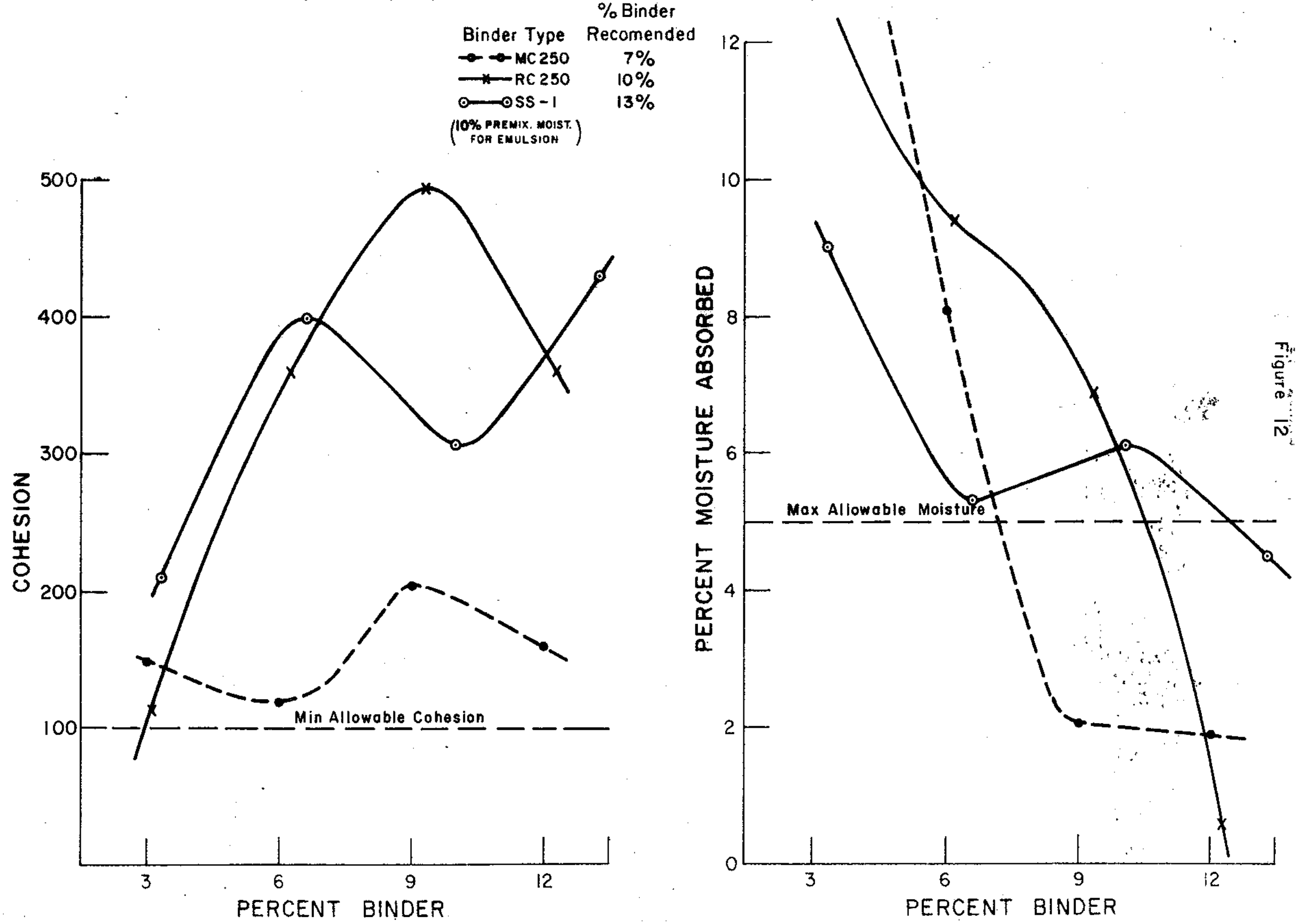
Figure 12

SAN JOAQUIN COUNTY SANDY SILT

PERCENT PASSING 200-81%

PERCENT BINDER VS COHESION

PERCENT BINDER VS MOISTURE ABSORBED



KINGS COUNTY SILTY SAND

PERCENT PASSING 200-30%

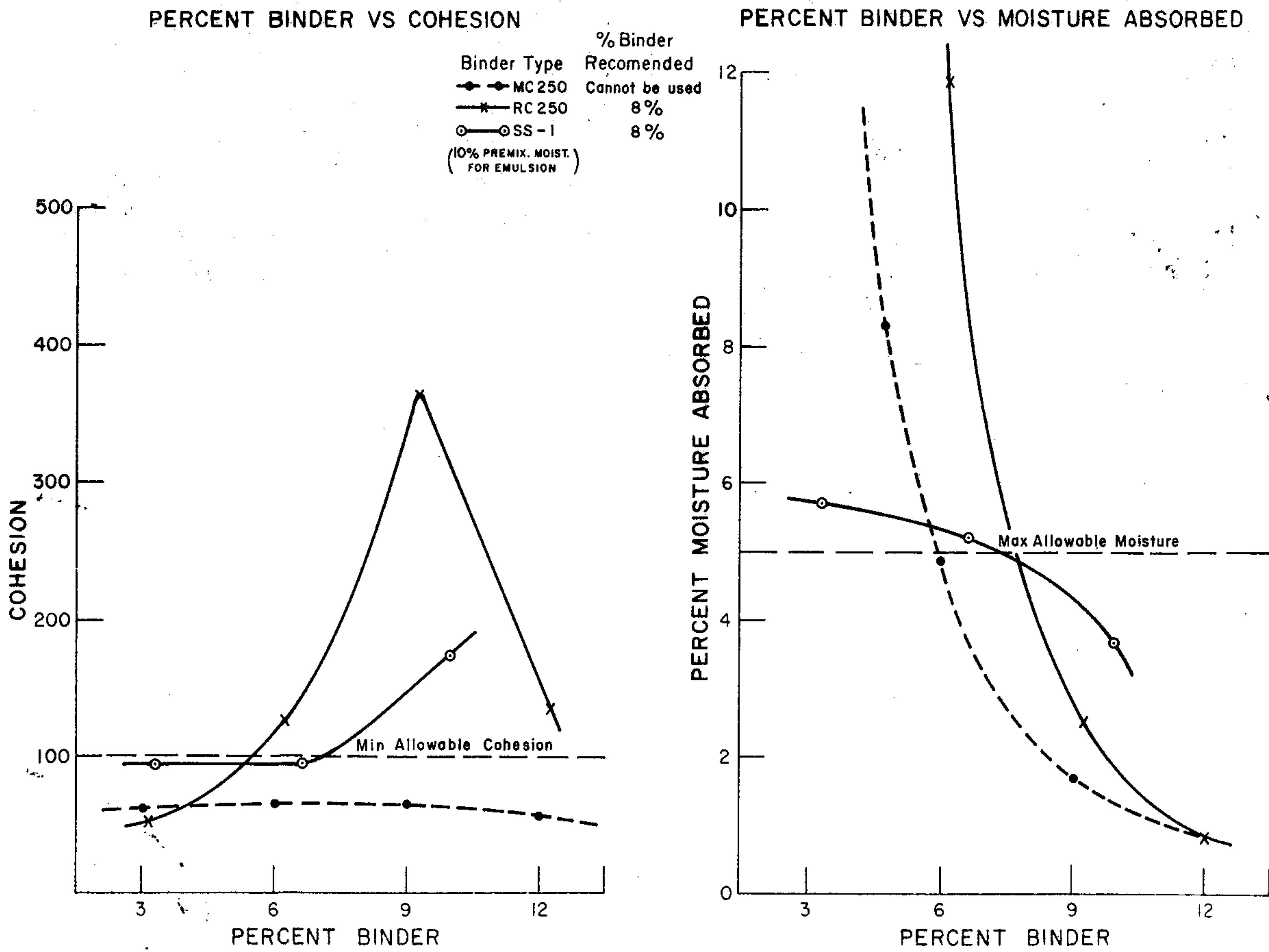


Figure 13

Figure 14

YOLO COUNTY SAND

PERCENT PASSING 200- 0%

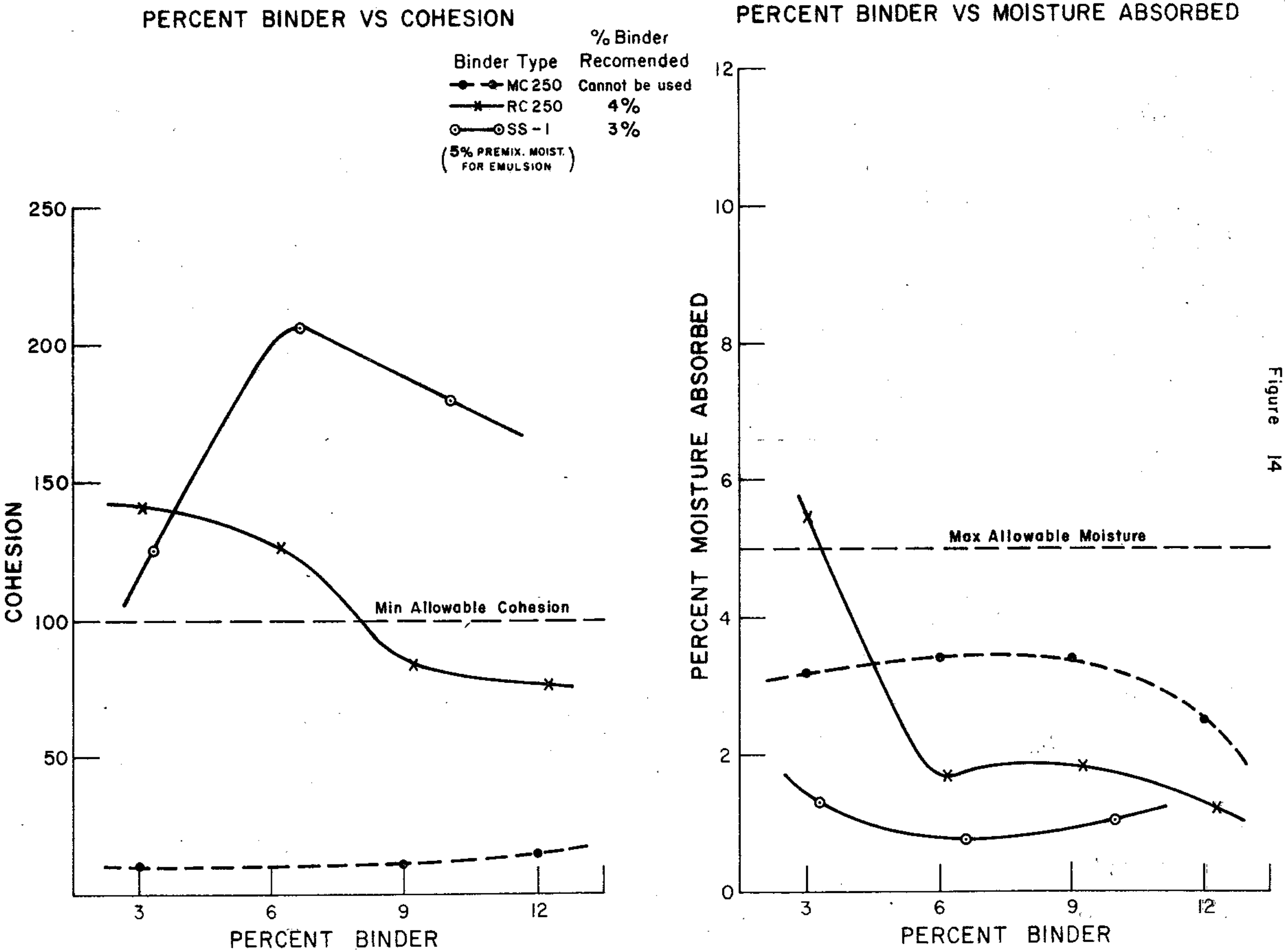


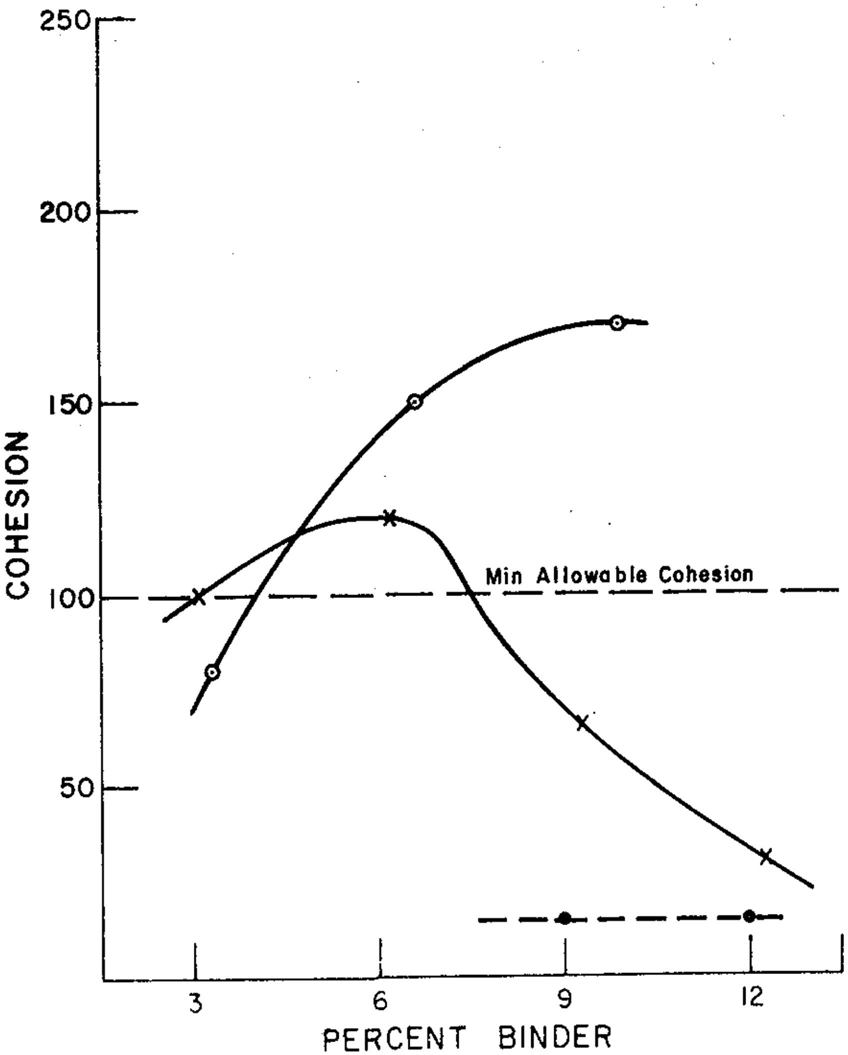
Figure 15

EL DORADO COUNTY DECOMPOSED GRANITE

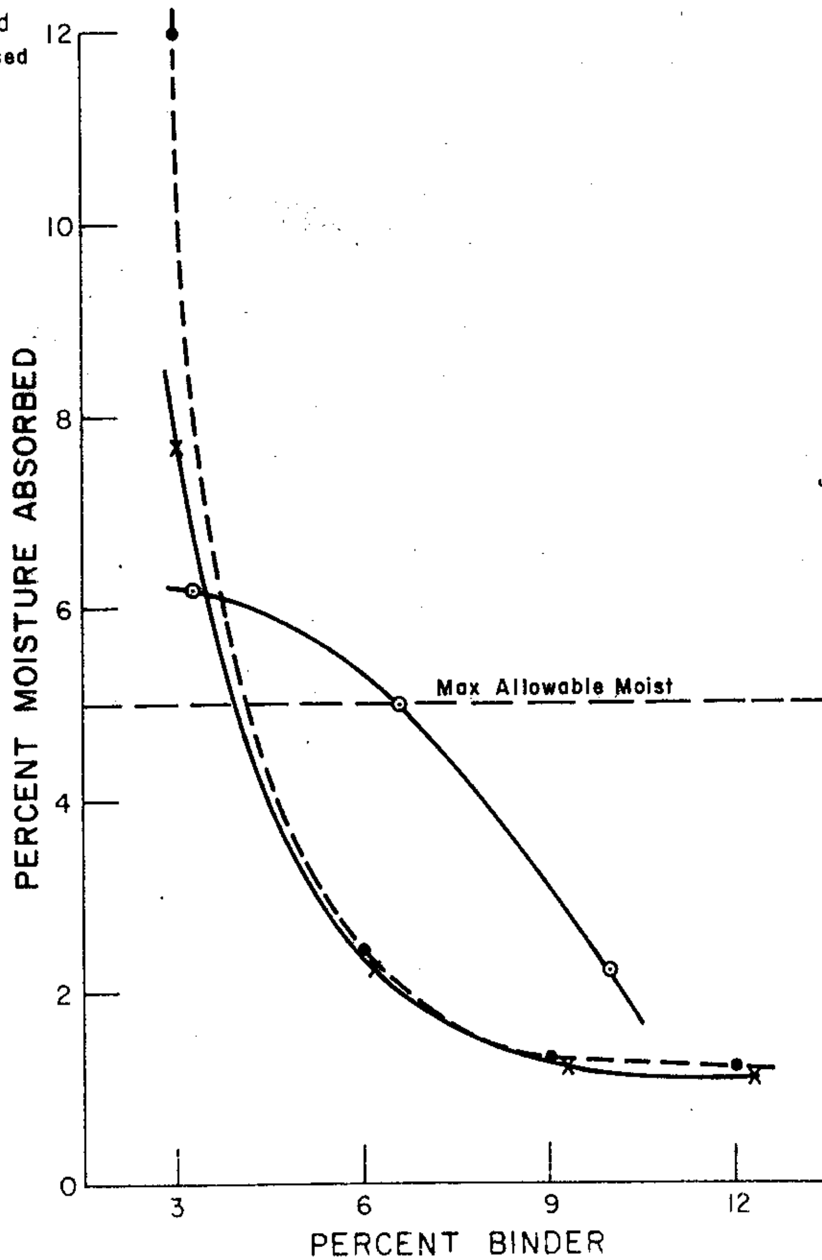
PERCENT PASSING 200-4 %

Binder Type	% Binder Recomended
MC 250	Cannot be used
RC 250	5%
SS - 1 (2% PREMIX. MOIST. FOR EMULSION)	7%

PERCENT BINDER VS COHESION



PERCENT BINDER VS MOISTURE ABSORBED



APPENDIX

METHOD OF SELECTION OF OPTIMUM BINDER CONTENT FOR BITUMINOUS TREATED BASE

1. Oven dry aggregate to a constant weight to remove all moisture.

2. Weigh out approximately 1200gms of aggregate for each specimen, and use liquid asphalts or emulsions, to prepare a series of specimens in 2 percent increments, starting with a binder content of 3.0 percent, (based on dry weight of the aggregate) and concluding with a binder content of 13.0 percent. Mix thoroughly with mechanical mixer or by hand. See notes at end of test method for mixing emulsion treated specimens.

3. Fabricate test specimens by placing sufficient material in a 4" diameter tared steel mold to provide a height after compaction of 2.5" ± 0.1".

4. Compact the specimen with a 40,000 lb. static load applied using a double plunger. The load is applied at a rate of 0.25 in./min.

5. Place specimen and mold in an oven maintained at 140°F ± 5° for 24 hours ± 30 minutes; remove and allow to stand at room temperature (78°F ± 10°) for 24 hour ± 30 minutes.

6. Attach perforated base plate to mold. Tare all equipment before fabricating.

7. Weigh entire assembly and obtain weight of sample by subtracting total tare weights from total weight.

8. Place assembly in a pan of water 1" in depth. Maintain water depth for the entire time of test. Water is at room temperature.

9. After 24 hours ± 30 minutes, remove entire assembly from water bath and record weight. Calculate the amount of water absorbed.

10. Repeat step 9 for 5 consecutive days.

11. At the end of 5 days soaking, record the final amount of water absorbed.

12. Press sample from mold and immediately test for cohesion following Test Method No. Calif. 306. However, this test shall be made at room temperature. Handle carefully to avoid damaging sample.

13. Use the B.T.B. recommendation chart and plot cohesion and moisture content versus percent binder content for each series representing a grade of asphalt or emulsion (see chart, page A-3.)

14. Select from each series the minimum binder content that will provide both a minimum cohesion of 100 and a maximum moisture uptake of 5.0 percent.

15. Report a minimum asphalt content for each grade of asphalt or emulsion tested.

Note: Various grades of asphalt cen be used for testing because an aggregate may be better stabilized with one grade than another. Should the engineer, for some reason, desire a particular grade, that grade should be designated and additional testing of other grades may be omitted. When emulsion is used a premix moisture content will be necessary to prevent the emulsion from "breaking" while mixing. The amount will be dependent on the aggregate used. After curing (24 hours @ 140°F and 24 hours at room temperature) the moisture in the samples from either premixing or emulsion should be ignored and the weights obtained should be considered as dry weight from this point on. (Percent of moisture uptake due to capillary absorption shall be calculated on this basis.) When compacting emulsion treated specimens, free moisture may briefly be noted, but this should not be extensive enough to flow from the specimen. If moisture flow is noted, additional samples with less premix moisture should be prepared until the flow of moisture is halted.

Figure 16

BTB RECOMMENDATION CHART

PERCENT BINDER VS COHESION

PERCENT BINDER VS MOISTURE ABSORBED

AGG. NO. ____________

BINDER TYPE ______

% BINDER REC. ______

%(-200) ______

% PRE MOIST. WATER ______